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of the Tree , hath contracted a petrified Crust , about the thickness of a *Billings*, all over the woody part within the Bark, the Marks of the Axe also remaining very conspicuous, with this petrified crust upon it. By what means it should thus happen , cannot well be conceived , in regard there is no water neer it ; the part, above the ground and out of the weather ; the Tree yet growing : unless being cut at some season, when the sap was flowing , the owling of the sap might become petrified by the Air , and the Tree grow rotten and hollow inward since that time ; which how long since, is not known.

A piece of that part cut , was presented , together with this Account , to the said *Society*, for their *Repository*.

### *Articles of Inquiries touching Mines.*

What the Honourable *Robert Boyle* gave the Reader cause to hope for, in *Numb. 11.* when he was pleased to impart those *General Heads* for a Natural History of a Country, there publish'd; He is not un-mindful to perform , by enlarging them as occasion serves, with *Particular* and *Subordinate Inquiries*. Here he gratifies the Curious with a considerable Set of Inquiries about *Mines* : which though unfinish'd, yet the *Publisher*, was instant to obtain their present Publication, to the end, that he might the more conveniently recommend them to several Forreigners of his Acquaintance ; now ready to return to their several Countries, which he understands to abound in Mines ; and from the Curious Inhabitants whereof, he expects to receive a good Accompt upon some at least of these Inquiries ; which also by several of them have been earnestly desired, as Instructions, to direct them , what Particulars to inquire after upon this Subject.

These Quæries are reduced by the *Author* to six Heads :

The *first*, The neighbouring Country about the Mines.

The *second*, The Soyl where the Mines are.

The *third*, The Signs of Mines.

The *fourth*, The Structure and other particulars belonging to the Mines themselves.

The *fifth*, The Nature and Circumstances of the Ore.

The *sixth*, the Reduction of the Ore into Metal.

*Quæri*

## QUÆRIES

### *About the first Title.*

1. Whether the Country be Mountainous, Plain, or distinguish'd with Vales? And in case it be mountainous, what kind of Hills they are; whether high, or low, or indifferently elevated? Whether almost equal or very un-equal in height? Whether fruitful or barren; cold or temperate; rocky or not; hollow or solid? Whether they run in ridges, or seem confusedly placed; and, if the former, what way the ridges run, North and South, &c. And whether they run any thing parallel to one another?

2. Whether the Country be barren or fruitful? And, if any way fruitful, what it produces, and what it most abounds with?

3. What Cattle it nourishes, and whether they have any such thing peculiar in point of bigness, colour, shape, longevity, fitness or unfitness to make good meat, &c. as may be rather ascribed to the peculiar nature of the place, than to the barrenness of the Soil, or other manifest causes?

4. Whether the Natives, and other Inhabitants, live longer or shorter than ordinary? Whether they live more or less healthy? Whether they be subject to any *Epidemical* Diseases, that may very probably be imputed to the Mines; and what these Diseases are; and what Remedies are found successful?

5. Whether the Country be, or be not furnish'd with Rivers, Brooks, Springs, and other Waters; and how these waters are conditioned?

6. Whether the Air be dry or moist; hot or cold; clear or foggy; thick or thin; heavy or light; and especially, whether the Weather be more or less variable than ordinarily; or whether it be subject to great and sudden changes, that may probably be imputed to the Mineral and Subterraneous Steams; and what they are?

*About the second Title.*

7. Whether the *Soyle* that is neer the Surface of the Earth, be Stony; and, if it be, what kind of Stones it abounds with? Whether it be Clayie, Marley, Chalkye, &c. And, if it be of several kinds, how many they are; and by what properties they are distinguish'd?

*About the third Title.*

8. By what *Signs* they know or guefs, that there is a Mine in such a place?

9. These Signs are *either* upon the Surface of the Earth, *or* beneath it.

To the *former* belong these *Quaries*.

10. Whether the Ground be made barren by Metalline or Mineral Effluviiums?

11. Whether it be observed, that Trees and other greater Plants seem to have their tops burnt, or other leaves or outsides discoloured? or whether there be any Plants, that do affect to grow over such Mines; and whether it have been tryed, that other Plants, that would prosper in the adjacent places, will not be made to grow or thrive there?

12. Whether the Stones and Pebles, that are wash'd by the Brooks, Springs, or other Waters, have any colour'd substance left upon them; and if they have, of what colour, weight, &c. these adherences are?

13. Whether the Waters of the place propos'd, do by their tast, smell, ponderousness, &c. disclose themselves to contain Minerals? And, if they do, what Minerals they or their residences, when they are evapourated away, do appear to abound with, or to participate of?

14. Whether *Snow* will not lye, or *Frost* continue so long, or *Dew* be generated or stay upon the ground in the place propos'd, as on other neighbouring grounds?

15. Whether the *Dew* that falls on that ground, will discolour white Linnen or Woollen-Cloths, spread over night on the surface

surface of the ground, and employed to collect the Dew ? And whether the *Rain* that falls there, and may be supposed to come thither from elsewhere, will discolour such Clothes, or afford any residence of a Mineral Nature ?

16. Whether the Place be more than ordinarily subject to Thunder and Lightning, and to sudden Storms or Earthquakes ; as likewise to Nocturnal Lights and fiery Meteors.

17. Whether Mists use to rise from Grounds stored with Minerals ? What is observable in them, and what Minerals they signify, and may be supposed to be produced by ?

18. Whether the *Virgula Divinatoria* be used to find out the Veins of proposed Mines ; and, if it be, with what success ?

19. What other Signs above ground afford probability of Mines, or Direction for following a Vein over Hills, Valleys, Lakes, Rivers, &c.

The *second* sort of *Signs* belonging to these *Queries*, are such as follow.

20. Whether there be any Clays, Marles, or other Mineral Earths, yellow or liquid matters, that usually give notice of the Ore ? And if there be more than one, how and at what depths they are wont to lye respectively ? Of what thickness and consistence they are ; and in what Order the Diggers meet with them ?

21. Whether there be any Stones or *Marchasites* to be found neer, or not very far from the surface of the ground, by which one may have ground to expect a Mine ? As is often observed in the Tin-Mines of *Cornwall*, over which such kind of Stones are divers times found lying above ground ?

22. Whether all Stones of that kind do equally signify that Mine ? And, if not, how the significant Stones are to be known, as by Colour, Bigness, Shape, Weight, Depth under ground, &c.

23. Whether there be any Earths of peculiar kinds, as to Colour, Consistence, &c. that indicate a Mine beneath or near them ; and, if there be, what they are, and what is their consecution, if they have any ?

24. Whether Heat or Damps give any assurance or a probability of finding a Mine ?

25. Whether

25. Whether Water of any kind , met with in Digging , especially at this or that depth , do betoken a Mine ?

26. Whether there be any Signs of the nearness of the Mine, and what they are ?

27. Whether there be any Signs of ones having mis'd the Mine , either by being past above ; or beneath , or having left it on either hand ; and what they are ?

28. Whether there be any Signs not only of the distinct and determinate kind of Metals or Minerals ; but of the Plenty and Goodness of the Vein ; and what they are ?

29. Whether there be any Signs of the depth of the Vein beneath the surface of the Earth ; and what they are ?

30. Whether there be any proper or peculiar Signs , that show it to be hopeless , or at least unlikely , to find a Vein in the place where it is digg'd for ; and what those are ?

### *About the fourth Title.*

31. What is the depth of the Shaft or Groove (which though named in the *singular* Number , the Questions about it are *generally* applicable ) till you come at the Vein or Ore ?

32. Whether the Vein run or lye Horizontal , or dippe ? And if it dippe , what *inclination* it hath , how deep the lowest part lies ; and consequently how much deeper than the uppermost ? As also , what it's Flexures , if it have any , are ? And whether it runs directly *North* or *South*, *East* or *West* ; or seem rather to have a Casual tendency , than any determinate one by Nature ? and how far it reaches in all ?

33. What is the Wideness of the Groove at the Top , and elsewhere ? Whether the Groove be perpendicular or crooked ; and if crooked , after what manner , and with what distance it winds ?

34. How the Groove is supported ? What are the kinds , length , bigness , and way of placing the Timber , Poles , &c. that are employed to support it ? And how long the Wood will last , without being spoyled with the subterraneous fumes and waters ? and what wood lasts longest ?

75. What Air-shaft belongs to the Mine? Whether it be *single*, or more than One? Of what breadth the Air-shaft is at the Orifice? Whether it be convenient enough, or not? How neer it is placed to the Groove; and in what position? And if there be *several* Air-shafts, what their Distances and scituation are in reference to the Groove, and to each other? Or how Air is supplied, if there be no Air-shafts?

36. Whether they meet with any Waters in the Mine? And, if they do, how copious they are; at what depths they occur; how they are qualified; and what way they Spring, &c.

37. Whether they are constant or temporary? whether they increase or diminish notably in Summer or Winter, or at any other time of the year; and if they do, at what season that is; how long it is wont to last; and the proportions of Increase and Decrease?

38. What Expedients and Engines are employed to free the Mines from Water? The materials, the parts, the bigness, the shapes, the coaptation; and, in short, the whole structure, number, and way of applying the Instruments, that are made use off to free the Mines from Water?

39. What are the Conditions, Number, &c. of the *Adits*?

40. Whether the Mine be troubled with *Damps*, and of what kind they are? whether they come often or seldom at any set time, or altogether irregularly? what Signs fore-run them? what mischief they do? what remedies are the most successfully employed against them, as well in reference to the Cleering of the Mine, as to the Preservation and Recovery of the *Workmen*?

41. What Methods the Mine-men use in following the Vein, and tracing their passages under ground (which they call *Plumming* and *Dyalling*) according to the several exigencies? And whether they employ the Instruments, made with the help of the Load-stone, the same way that is usual; and if not, wherein they differ in the use of the same Instruments; or what Instruments they substitute in their place?

42. What ways they take to secure themselves from the uncertainty, incident to the guidance of *Magnetick* Needles from the *Iron-Stone* or Ore, that they may meet with under ground?

(of

( of which yet perhaps there is not so great danger , as one may imagine ; as far as I could find by a Trial , I purposely made in a Groove ; where I was sure , there wanted not Iron-Ore.) And what other wayes may be used to direct Miners without the help of a Load-stone ?

43. How the Miners deal with the Rocks and Sparrs , they often meet with , before they come at the Ore ? Whether they use Fire to soften , calcine, or crack them ? How they employ it , and with what measure of success ?

44. What wayes and cautions they use , to free the Mine and secure the Work-men from the inconveniencies and danger accruing from the use of much fire in it ?

45. What Instruments they use to break the Rock &c ? And how those Instruments are conducive ; and how long they last ?

46. How the Mine-men work ; whether naked or cloathed ? And what Lights they use to work by ; what materials they are made of , what measure of light they give ; how long they last ; and by what wayes they are kept burning in that thick and foggy air ?

47. How Veins are follow'd, lost , and recover'd ? And how several Miners work on the same Vein ? And what is the best way of getting all the Ore in a Vein , and most conveniently ?

48. How they convey out their Ore , and other things , that are to be carried out of the Mine ? Whether they do it in Baskets drawn up by Ropes , or upon Mens backs ; and if this last-named way ; what kind of Vessels they use for matter, shape , and capacity ? And whether the Work-men deliver them one to another ; or the same Work-men carry them all the way ? And whether the Diggers descend and ascend by Ladders of Wood , or of Ropes , &c.

### *About the Fifth Title.*

49. Whether the Ore runs in a Vein ; or lie dispers'd in scatter'd pieces ; or be divided partly into a Vein , and partly into loose masses ; or like a Wall between two Rocks , as it were in a Cleft ; or be interspers'd in the firm Rock , like speckled Marble ? Or be found in *Grains* like *Sand* or *Gravel* ; as store  
of



of excellent *Tin* is said to be found in some parts of *Cornwall* at the Sides and in the Channels of running Waters, which they call . . . . . ; or whether the Ore be of a softer consistence, like *Earth* or *Lome*, as there is Lead-ore in *Ireland* holding store of Silver, and Iron-ore in the North parts of *Scotland* and elsewhere? And what is observable in it as to Weight, Colour, Mixture, &c?

50. Whether any part of the Metal be found in the Mine perfect and complete? ( As I have had presented me good valuable *Copper*, and pieces of perfect *Lead*, that were taken up, the one at *Jamaica*, and the other by an acquaintance of mine, that took them out of the ground himself in *New England*.)

51. Whether the Mine affords any parcels of Metal, that seem to grow like *Plants* ( as I have sometimes seen Silver growing, as it seemed, out of Stone, or *Sparre* almost like blades of Grass; as also great Grains of a Metal, which appear'd to me, and which those, that tryed some of it, affirmed to be Gold, abounding in a stony lump, that seem'd to consist chiefly of a peculiar kind of *Sparre*.)

52. Whether the Vein lie near, or much beneath the surface of the Earth, and at what depth?

53. Whether the Vein have or have not any particular Concomitants, or Coats ( if I may so call them; ) and, if any, what they are, and in what order they lie? ( As the Veins of *Lead-ore*, with us, have frequently annexed to them a Substance call'd *Sparre*, and next to that another, call'd *Caulk*.)

54. Whether ( besides these Coats ) the Vein have belonging to it any other *Heterogeneous* substance? ( As in *Tin-mines* we often find that yellow substance, which they call *Mundick*.)

55. What are the principal Qualities of these Extraneous substances? ( As that *Sparre* is white, but transparent, almost like coarse *Crystall*, heavy, brittle, easily divisible into flakes, &c. *Caulk* is of a different texture, white, opacous, and like a Stone, but much more ponderous. *Mundick* I have had of a fine golden colour; but, though it be affirm'd to hold no Metal; yet I found it in weight, and otherwise, to differ from *Marchasites*; and the Mine-men think it of a poisonous nature.)

56. Whether the Vein be inclosed every way in its Coats ; or whether it only lye between them ?

57. Whether the Vein be every way of an uniform breadth , and thickness ; and , if it be , what these Dimensions are ; and , if not , in what places it varies , and in what measures ? ( The like Questions are to be made concerning the *sparre*, *Caulk*, and other Teguments or mixtures of the Ore ? )

58. VWhether the Vein be un-interrupted, or in some places broken off ; and whether it be abruptly, or not ; and whether it be by Vales, Brooks, Gulleys, &c.

59. How wide the Interruptions are ? what Signs, whereby to find the Vein again ? whether the ulterieur part or division of the Vein be of the same Nature , and hold on in the same Course , as to its tendency upwards or downwards , or Horizontally , Norward , Southward, &c. with the Vein , from which it is cut off ?

60. VWhether , in case the last end of the Vein be found , it terminate abruptly , or else end in some peculiar kind of Rock or Earth , which does , as it were , close or Seal it up, without leaving any crack or cranny , or otherwise ? And whether the terminating part of the Vein tend upwards , downwards , or neither ? And whether in the places, where the Vein is interrupted, there be any peculiar Stone or Earth , that does , as it were , seal up the Extremity of it ?

61. Whether it be observed , that the Ore in Tract of time may be brought to afford any Silver or Gold, which it doth not afford , or more than it would afford , if it were not so ripe ? And whether it have been found , that the Metalline part of the Vein grows so , that some part of the Mine will afford Ore or Metal in tract of time , that did not so before ? And whether to this Maturation of the Mine , the being exposed to the free Air be necessary ; or , whether at least it conduce to the Acceleration of it ; or otherwise ?

62. Whether all the Ore , contained in the Mine , be of the self-same nature and goodness ; and , if not , what are the differing kinds ; and how to be discriminated and estimated ?

63. VWhat is the fineness and goodness of the Ore , by which the Mine is wont to be estimated ? And what are the marks and characters,

characters, that distinguish one sort from another?

64. VVhat proportion of Metal it affords? (As in our *Iron-mines* 'tis observed, that about three Tuns of Iron-stone will afford one Tun of Metal: And I have had *Lead-Ore*, which an Ingenious man, to whom I recommended such Tryals, affirm'd to me to afford three parts in four of good Lead.)

65. VVhether the Ore be pure in its kind from other Metals, and, if not, of what Metals it participates; and in what proportion? Which is especially to be inquired into, in case the Mine be of a *base* metal, that holds a *noble* metal: (As I have known it observ'd, that *Lead-Ore*, that is poor in its own metal, affords more Silver, than other; and I remember, that the Ore lately mention'd, being rich in Lead, scarce afforded us upon the *Cappel*, an Atome of Silver. And *Matthæius* informs us, that a little Gold is not unfrequently found in *Iron-Ore*. And I have by me some Gold, that never endur'd the Fire, taken out of a Lump of Tin-Ore.)

*About the sixth Title.*

66. VVhat are the mechanick and prævious Operations, as Beating, Grinding, VVashing, &c. that are used to separate the Ore from the Heterogeneous Bodies, and prepare it for the Fire? Or whether the Ore requires no such preparation? (as it often happens in Lead, and sometimes in Iron, &c.)

67. VVhether *Mercury* be made use off, to extract the nobler from the baser metals? (as is their practice in *Peru*, and other parts of the *West-Indies*.)

68. VVhether the leaving the Ore expos'd to the open Air and Rain for a good while, be used as a Præparative? (as I have seen done in *Iron-stone*.)

69. VVhether the Burning and Beating of the Ore be used to prepare it for the Furnace? (as is practis'd in *Iron*, and almost always in *Copper*;) And, in case they use it more than once, how often they do it; (for, *Copper-Ore* is in some places washed 8. or 10. times, and in others, 12. or 14.) and with what circumstances; as, how long the Ignition lasts at a time, whether the Ore be suffer'd to cool of it self, or be quench'd? whether it be washed betwixt each Ignition?

70. VVhat Flux-powders, and other ways they have to try  
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and examine the goodness of the Ore in small quantities?

71. Whether, when they work in *great*, they use to melt the Ore with any Flux or Additaments, or only by the force of the Fire, or in any way between both? (As throwing in of Charcoals when they melt Iron-stone does not only serve to feed the Fire, but perhaps by the *Alchaly* of its Ashes to promote the fusior: so Lime-stone, &c.)

72. What kind of Furnaces they use, to melt the Ore in? Whether they be all of one sort and bigness, or of differing?

73. What are, the Situation, Materials, Dimensions, Shape, Bigness, and in short what is the whole structure and Contrivance of the Furnace? If there be any thing peculiar and remarkable? What Tools are used in Smelting, their Figures, use, &c. And the whole manner of working?

74. What kinds of Fewel, and what quantities of it, are wont to be employed in the Furnace, within the compass of a day, or week? How much is put in at a time? How often it is renewed? And how much Ore in a determinate time, as a week or a day, is wont to be reduced to Metal?

75. In case an Additament be employed, what that is, and in what proportion it is added? Whether it be mingled with the Ore, before that be put into the Fire, or cast in afterwards; and, if so, at what time, &c?

76. Whether the Ore be melted by a Wind, excited by the Fire it self; as in Wind-ovens? Or by the course of Waters? Or actuated by the blast of Bellows; and, if so, whether these Bellows be mov'd by a Wheel, turn'd by Water running under it, or falling on it? And what are, the Dimensions, Situation, &c. of the Bellows?

77. What contrivance they have, to let or take out the Metal, that is in fusion; and cast it into Barrs, Sows, Pigs. &c?

78. What Clay, Sand, or Mould they let it run or pour it through? And after what manner they refrigerate it?

79. Whether or no they do, either to facilitate the fusion, or to obtain the more or better Metal, mingle differing sorts or degrees of Ore of the same metal? (As in some places 'tis usual, to mingle poor and rich Ore; and at *Mendip* they mix two or more of those differing kinds of *Lead-ore* that they call *Frim-ore*, *Steel-ore*, *Potern-ore*, &c.)

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82. VVhether or no , having once brought the Ore to fusion , they melt all the Metal it self , to have it the more pure ? And, if they do ; with what circumstances they make the fusion ?

83. VVhether they have any Signs , whereby to know whether the Fusion have been well or ill perform'd ; and the Metal have obtain'd the perfection , to be expected from such Ore, melted in such a Furnace ?

84. VVhether they observe any great difference in the goodness of the Metal , that first melts, from that of the rest of the Metal which comes afterwards in the same or another operation ? And whether the Rule holds constantly ? ( For, though they observe in *Tin-Mines*, the best Metal comes first , yet in the works of an Industrious friend of mine , he informs me, that the best Metal comes last.)

85. Whether the produced Metal be all of the same goodness ? And if it be , how good it is in reference to the Metal of other Mines, or other parts of the same Mine or Vein ? And if it be not, what differences are observ'd between the produced portions of Metal ; and what disparity that amounts to in the price ?

86. What are the Wayes of distinguishing them , and estimating their goodness ?

87. Whether they do any thing to the Metal , after it is once brought to Fusion , and, if need be , melt it over again, to give it a melioration ? ( As when *Iron* is refined , and turn'd into Steel ; ) And what distinct Furnaces, and peculiar Ways of ordering the Metals are employ'd to effect this improvement ? With a full description of them and the Tools in all Circumstances, observ'd in the refining of Metals.

88. Whether in those places , where the Metal is melted, there be not elevated some Corpuscles , that stick to the upper parts of the Furnance , or Building ? And, if there be , whether they be barely fuliginous and recrementitious exhalations, or, at least in part , Metallin Flowers ? ( As in the *Cornish* Tin-mines, after some years they usually destroy the thatch'd Houses , where the Ore hath been melted , to get the stuff, that adhears to the insides of the Roofs, out of which they melt store of excellent Tin. )

89. Whether the Metal, being brought to fusion , affords  
any

any Recrements? ( As *Iron-stone* affords store of a dark Glas or Slagg ) And, if it do, what those Recrements are? How t<sup>y</sup> are separated from the Metal; and to what Uses they are employed?

90. Whether, after the Metal has been once melted, the remaining part of the Ore being exposed to the Air, will in tract of time be impregnated, or ripen'd, so as to afford more Metal? ( For, this is affirm'd to me of the *Cornish Tin-Ore*; and what remained after the fusion of *Iron-ore* in the *Forest of Dean*, is so rich in Metal, that a Tenant of mine in *Ireland*, though he had on the Land, he held from me, an *Iron-Mine*, found it less profit to work it, than to send cross the Sea to the *Forest of Dean* for this already us'd Ore, which having lain for some ages, since it was thrown aside in great heaps expos'd to the Air, he affirm'd to yield as well great great store of Iron, as very good: though I somewhat doubt, whether this be *totally* to be ascribed to the Aire, and length of time; or to the leaving of Metal in the Slaggs in old times, before great Furnaces were in use.)

### *Promiscuous Inquiries about Mines, from the same Author.*

1. Whether the Territorie, that bears the Mine, abounds with no other Kind of Mineral in some distinct part of it? ( As in *Kent* near *Tunbridge*, one part of the Country which is Hilly, abounds all along with *Iron-Mines*; the other, which is also Hilly, and divided from it but by a small Valley, abounds exceedingly ( as the Diggers and Inhabitants told me upon the place ) in *Quarry's*, which the Metallin-Country wants, but is quite destitute of *Iron-stone*. And so at *Mendip*, in one part of the Hill, I saw store of *Lead-Mines*, containing several Kinds of Ore of that Metal; another part of the Hill I found to be full of *Cole-pits*, which had some *Marchasites*, but no Metal; and in another place, *Iron-ore*, and mixt with Ores, which yet they did not think fit to work.)

2. Whether the Air appear to be really cold in Summer,  
and

and hot in Winter at the bottom of the Mines, by surer proofs than the Testimony of our Touch ?

3. Whether they ever meet with places and Stones actually very hot, as *Matthæus* relates ? And whether that spring not from the quenching of *Marchasites* ?

4. Whether they find in the Mines any Mineral Gelly, such as the *German* Naturalists call *Ghur* ? And whether in process of time it will harden into a metal, or Mineral Concretion ?

5. What are the Laws, Constitutions, and Customs, *Oeconomical*, *Political*, *Ethical*, that are receiv'd and practis'd among the Mine-men ?

6. Whether the Diggers do ever really meet with any subterraneous *Demons* ; and if they do, in what shape and manner they appear ; what they portend ; and what they do, &c. ?

7. Whether they observe in the Trees and other Plants, growing over or neer the Mine, not only, (as hath been already intimated) that the Leaves are any whit gilded or silver'd by the ascending Mineral Exhalations, but also, that the Trees or other Plants are more solid and ponderous ? And if they have not also some discernable Metalline or Mineral Concretes, to be met with in the small Cavities and Pores of their substance ?

8. Whether there be not Springs, and also greater Streams of Water neer the Mine, that rise, and run their whole course under ground, without ever appearing above it ?

9. Whether the Subterraneous Springs do rise with any wind or determinate change of weather ?

10. How much heavier the *Atmosphere* is at the bottom of the Mine, than at the top ? And whether Damps considerably increase the weight of it ?

11. Whether they find any strange substances in the Mines, as Vessels, Anchors, Fishes inclos'd in Sparr or Metal, &c. ?